

DESCRIPTION

NAVIGATION DEVICE, NAVIGATION METHOD, NAVIGATION PROGRAM,  
AND COMPUTER-READABLE RECORDING MEDIUM

5

TECHNICAL FIELD

[0001]

The present invention relates to a navigation device,  
a navigation method, a navigation program, and a computer-  
10 readable recording medium.

BACKGROUND ART

[0002]

Conventionally, such a technology is disclosed that a  
driver can properly recognize a traveling direction by  
15 means of changing a direction of a guide voice being  
emitted by arranging a plurality of speakers for guidance  
(see, for example, Patent Document 1 and Patent Document  
2).

[0003]

20 Patent Document 1: Japanese Patent Laid-Open  
Publication No. H7-160996

Patent Document 2: Japanese Patent Laid-Open  
Publication No. H9-72752

DISCLOSURE OF INVENTION

25 PROBLEM TO BE SOLVED BY THE INVENTION

[0004]

In the above-mentioned conventional technology, however, even if the direction in which the guide voice is emitted is changed, since a 3D surround system is not used, it is incapable of making the guide voice sound as if the  
5 guide voice is moving. Hence, there has been a problem in which, in a traveling car, the direction of the traveling and the direction of the emitted guide voice do not always correspond to each other. This might cause an operator (driver) to feel uncomfortable.

10 [0005]

In addition, there has been a problem in which it cannot cause the operator to more intuitively recognize hazard information, attention-calling information, or the like in the traveling direction, by using the sound.

15 [0006]

Moreover, there has also been a problem in which a direction to a predetermined point, such as a destination, cannot be notified to the operator by only using the sound.

#### MEANS FOR SOLVING PROBLEM

20 [0007]

A navigation device according to the invention of claim 1 is provided with a 3D surround system including a plurality of speakers, and includes a guidance-information acquiring unit that acquires information on route  
25 guidance; and a control unit that controls output of a guide sound so that a direction from which the guide sound

is heard moves, based on the information acquired by the guidance-information acquiring unit, using at least two speakers among the speakers at the same time.

[0008]

5        Moreover, a navigation device according to the invention of claim 5 is provided with a 3D surround system including a plurality of speakers, and includes a guidance-information acquiring unit that acquires information on guidance; and a control unit that controls  
10        output of a guide sound based on the information acquired by the guidance-information acquiring unit using a speaker only for low-pitched sound reproduction and a speaker other than the speaker only for low-pitched sound reproduction among the speakers.

15        [0009]

         Furthermore, a navigation device according to the invention of claim 7 is provided with a 3D surround system including a plurality of speakers, and includes a predetermined-point-information acquiring unit that  
20        acquires information on a predetermined point; and a control unit that controls output of a guide sound so that the guide sound is heard from a direction of the predetermined point based on the information acquired by the predetermined-point-information acquiring unit.

25        [0010]

         Moreover, a navigation method according to the

invention of claim 9 uses a 3D surround system including a plurality of speakers, and includes a guidance-information acquiring step of acquiring information on route guidance; and a control step of controlling output of a guide sound  
5 so that a direction from which the guide sound is heard moves, based on the information acquired at the guidance-information acquiring step, using at least two speakers among the speakers at the same time.

[0011]

10 Furthermore, a navigation method according to the invention of claim 10 uses a 3D surround system including a plurality of speakers, and includes a guidance-information acquiring step of acquiring information on guidance; and a control step of controlling output of a  
15 guide sound based on the information acquired at the guidance-information acquiring step using a speaker only for low-pitched sound reproduction and a speaker other than the speaker only for low-pitched sound reproduction among the speakers.

20 [0012]

Moreover, a navigation method according to the invention of claim 11 uses a 3D surround system including a plurality of speakers, and includes a predetermined-point-information acquiring step of acquiring information  
25 on a predetermined point; and a control step of controlling output of a guide sound so that the guide

sound is heard from a direction of the predetermined point based on the information acquired at the predetermined-point-information acquiring step.

[0013]

5        Furthermore, a navigation program according to the invention of claim 12 causes a computer to execute any one of the navigation methods according to claims 9 to 11.

[0014]

10        Moreover, a computer-readable recording medium according to the invention of claim 13 stores therein the navigation program according to claim 12.

#### BRIEF DESCRIPTION OF DRAWINGS

[0015]

15        Fig. 1 is a block diagram illustrating an example of a functional configuration of a navigation device according to an embodiment of the present invention;

      Fig. 2 is a flowchart illustrating an example of a procedure of a process performed by the navigation device according to the embodiment of the present invention;

20        Fig. 3 is a flowchart illustrating another example of a procedure of a process performed by the navigation device according to the embodiment of the present invention;

25        Fig. 4 is a flowchart illustrating another example of a procedure of a process performed by the navigation device according to the embodiment of the present

invention;

Fig. 5 is a block diagram illustrating an example of a hardware configuration of the navigation device according to an example of the present invention;

5 Fig. 6 is an explanatory diagram illustrating an example of a typical guidance pattern of the navigation device according to the example of the present invention;

Fig. 7 is an explanatory diagram illustrating another example of a typical guidance pattern of the navigation  
10 device according to the example of the present invention;

Fig. 8 an explanatory diagram illustrating another example of a typical guidance pattern of the navigation device according to the example of the present invention;

Fig. 9 an explanatory diagram illustrating another  
15 example of a typical guidance pattern of the navigation device according to the example of the present invention;

Fig. 10 an explanatory diagram illustrating another example of a typical guidance pattern of the navigation device according to the example of the present invention;

20 Fig. 11 is a flowchart illustrating a procedure of a process performed by a navigation device according to an example of the present invention (Part 1);

Fig. 12 is a flowchart illustrating a procedure of a process performed by a navigation device according to an  
25 example of the present invention (Part 2);

Fig. 13 is an explanatory diagram illustrating

another example of a typical guidance pattern of the navigation device according to the example of the present invention;

Fig. 14 is an explanatory diagram illustrating  
 5 another example of a typical guidance pattern of the navigation device according to the example of the present invention; and

Fig. 15 is an explanatory diagram illustrating  
 another example of a typical guidance pattern of the  
 10 navigation device according to the example of the present invention.

#### EXPLANATIONS OF LETTERS OR NUMERALS

[0016]

	100: 3D surround system
15	101: guidance-information acquiring unit
	102: control unit
	103, 511-515: speaker group
	104, 516: low-pitched sound speaker (subwoofer)
	105: predetermined-point-information acquiring unit
20	500: navigation control unit
	501: user operation unit
	502: display unit
	503: position recognizing unit
	504: recording medium
25	505: recording-medium decoding unit
	506: guide-sound output unit

507: point retrieving unit

508: route searching unit

509: route guiding unit

510: guide-sound generating unit

5 BEST MODE(S) FOR CARRYING OUT THE INVENTION

[0017]

Exemplary embodiments of a navigation device, a navigation method, a navigation program, and a computer-readable recording medium according to the present  
10 invention will be explained in detail below with reference to the accompanying drawings.

[0018]

(Functional Configuration of Navigation Device)

First, a navigation device according to an embodiment  
15 of the present invention will be described. Fig. 1 is a block diagram illustrating an example of a functional configuration of the navigation device according to the embodiment of the present invention.

[0019]

20 As shown in Fig. 1, the navigation device installed in a vehicle (including a four-wheel vehicle and a two-wheel vehicle) or the like is configured so as to include a 3D surround system 100 including a plurality of speakers, a guidance-information acquiring unit 101, a control unit  
25 102, and a predetermined-point-information acquiring unit 105.



[0020]

The 3D surround system 100 has a speaker group 103 constituted by a plurality of speakers, and a low-pitched sound speaker (subwoofer) 104. The guidance-information  
5 acquiring unit 101 acquires information on route guidance.

[0021]

The control unit 102 controls, based on the information acquired by the guidance-information acquiring unit 101, output of a guide sound so that the direction  
10 from which this guide sound is heard moves by using at least two speakers included in the speaker group 103 at the same time. The control unit 102 also controls the output of the guide sound so that the guide sound is heard substantially from the front side in the traveling  
15 direction, and then moved substantially toward the guidance direction based on the information acquired by the guidance-information acquiring unit 101.

[0022]

In addition, the control unit 102 controls output of  
20 a sound effect included in the guide sound so that the sound effect is heard substantially from the front side in the moving direction, then moved substantially toward the guidance direction based on the information acquired by the guidance-information acquiring unit 101, and  
25 subsequently controls output of a guide voice of the guide sound so that the guide sound is heard substantially from

the guidance direction based on the information acquired by the guidance-information acquiring unit 101. The sound effect is a guide tone for calling attention, such as a sound "pong" or "ding dong".

5 [0023]

These controls may be carried out only for of the guidance given just before a branch point, and the usual guidance may be carried out for other guidance (for example, the guidance at 700 meters before the point, the  
10 guidance at 300 meters before the point, or the like).

[0024]

In addition, the control unit 102 may control the output of the guide sound based on the information acquired by the guidance-information acquiring unit 101  
15 using the low-pitched sound speaker (subwoofer) 104 and at least one speaker in the speaker group 103 at the same time.

[0025]

The control unit 102 may use the low-pitched sound  
20 speaker 104 based on hazard information or attention-calling information in the traveling direction among pieces of information acquired by the guidance-information acquiring unit 101.

[0026]

25 The predetermined-point-information acquiring unit 105 acquires information on a predetermined point. At

that time, the control unit 102 may control, based on the information acquired by the predetermined-point-information acquiring unit 105, the output of the guide sound so that the guide sound is heard from the direction of the above-mentioned predetermined point. The information on the above-mentioned predetermined point may be information on a destination point in route guidance or a registered point that has been arbitrarily set.

[0027]

10 (Procedure of Process by Navigation Device)

Next, a procedure of a process performed by the navigation device according to the embodiment of the present invention will be described. Fig. 2 is a flowchart illustrating an example of the procedure of the process by the navigation device according to the embodiment of the present invention. As shown in the flowchart in Fig. 2, the navigation device illustrated in Fig. 1 acquires guidance information in advance (step S201).

20 [0028]

Thereafter, using one or more speakers in the speaker group 103, the sound effect (for example, a tone) is output first so that it may be heard substantially from the front side in the traveling direction (step S202). Next, following the output heard substantially from the front side in the traveling direction at step S202, the

sound effect (for example, the tone) is output so that the sound effect is heard as if moving substantially toward the guidance direction based on the guidance information acquired at step S201 (step S203).

5 [0029]

Subsequently, the guide voice is output so that the guide voice is heard substantially from the guidance direction to which the above-mentioned guide tone is moved (step S204), and a series of process is ended. Thus, it  
10 can be intuitively recognized that the direction to which the guide tone is moved is the guidance direction, thereby making it possible to reduce misconception of the guidance direction.

[0030]

15 Fig. 3 is a flowchart illustrating another example of the procedure of the process by the navigation device according to the embodiment of the present invention. As shown in the flowchart in Fig. 3, the navigation device illustrated in Fig. 1 acquires the guidance information in  
20 advance (step S301).

[0031]

Next, it is determined whether the guidance information acquired at step S301 is the hazard information or the attention-calling information (step  
25 S302). If the guidance information is the hazard information or the attention-calling information (step

S302: YES), the subwoofer 104 is used along with a predetermined speaker in the speaker group 103 upon outputting the guidance information to output the guide sound (mainly, the guide tone) (step S303), and a series  
5 of the process is ended.

[0032]

Meanwhile, at step S302, if the guidance information is neither the hazard information nor the attention-calling information (step S302: NO), only the  
10 predetermined speaker in the speaker group 103 is used without using the subwoofer 104 to output the guide sound (step S304), and a series of the process is ended.

[0033]

As described above, by using the subwoofer 104 upon  
15 outputting the guidance information when the guidance information is the hazard information or the attention-calling information, it can be perceived unconsciously that there is a situation in danger or a situation that a  
attention must be called in the traveling direction,  
20 thereby making it possible to contribute to safer driving and travel.

[0034]

Fig. 4 is a flowchart illustrating still another example of the procedure of the process performed by the  
25 navigation device according to the embodiment of the present invention. As shown in the flowchart in Fig. 4,

the navigation device illustrated in Fig. 1 acquires the guidance information in advance (step S301).

[0035]

Next, it is determined whether a guidance request for  
5 the predetermined point (for example, the destination  
point in the route guidance or the registered point that  
has been registered in advance) is made from the operator  
(for example, the driver) (step S401). If no guidance  
request is made (step S401: NO), the process is ended  
10 without doing anything. Meanwhile, if the guidance  
request is made (step S401: YES), the guide sound (for  
example, the guide tone, the guide voice, or the like) is  
output so that the guide sound is heard from the direction  
of the above-mentioned predetermined point (step S402),  
15 and a series of the process is ended.

[0036]

As described above, by notifying the direction of the  
predetermined point (for example, the destination point or  
the registered point) with the guide sound, it is possible  
20 to readily recognize the direction of the predetermined  
point, such as the destination point or the registered  
point toward which the vehicle is traveling at present,  
without checking a display screen.

EXAMPLE

25 [0037]

(Hardware Configuration)

Next, a hardware configuration of the navigation device according to an example of the present invention will be described. Fig. 5 is a block diagram illustrating an example of the hardware configuration of the navigation device according to the example of the present invention.

5 [0038]

As shown in Fig. 5, the navigation device has a configuration that includes a navigation control unit 500, a user operation unit 501, a display unit 502, a position recognizing unit 503, a recording medium 504, a recording-  
10 medium decoding unit 505, a guide-sound output unit 506, a point retrieving unit 507, a route searching unit 508, a route guiding unit 509, a guide-sound generating unit 510, a right front speaker (SP) 511, a left front SP 512, a  
15 center SP 513, a right rear SP 514, a left rear SP 515, and a subwoofer 516.

[0039]

The navigation control unit 500 controls the whole navigation device. The user operation unit 501 includes a  
20 manual operation button, a remote controller, a touch panel, or the like. The display unit 502 includes a liquid crystal display, an organic EL display, or the like.

[0040]

The position recognizing unit 503 acquires self-  
25 vehicle position information. The self-vehicle position information herein is to receive an radio wave from a GPS

satellite to calculate for a geometric position with respect to the GPS satellite, and as a matter of course, the measurement can be carried out anywhere on the earth.

As the radio wave, an L1 wave, which is a carrier wave of

5 1,575.42 MHz containing a C/A (Coarse and Access) code and a navigation message, is used. Thus, the current position of the vehicle (latitude and longitude) is detected. The information collected by various sensors, such as a speed sensor and a gyro sensor, may be added.

10 [0041]

The recording medium 504 is, for example, a hard disk (HD). The recording medium 504 may be, instead of or in addition to the HD, a removable recording medium such as a DVD, a compact disk (CD), or the like. The recording-

15 medium decoding unit 505 controls reading/writing from/to the HD, the DVD, or the CD.

[0042]

The navigation control unit 500 outputs which position on a map the vehicle is traveling to the display unit 502 based on the self-vehicle position information calculated by the position recognizing unit 503 and map DB information acquired from the recording medium 504 through the recording-medium decoding unit 505.

[0043]

25 The guide-sound output unit 506 creates stereophonic sounds by controlling the output to the connected speaker.



[0044]

The point retrieving unit 507 retrieves an arbitrary point to output to the display unit 502 based on the information input from the user operation unit 501. The  
5 route searching unit 508 computes an optimal route to this point based on the point information acquired by the point retrieving unit 507. The route guiding unit 509 generates real-time route guidance information based on the information acquired by the route searching unit 508 and  
10 the self-vehicle position information.

[0045]

The guide-sound generating unit 510 generates data of the tone corresponding to a pattern and of the voice. In other words, based on the route information, setting of a  
15 virtual sound source and generation of voice guidance information corresponding to a guidance point are carried out to be output to the sound output unit. Data generation of the tone and voice may be carried out by setting up to compute the virtual sound source in real  
20 time, or by setting up the virtual source in accordance with the guidance pattern assumed in advance and reading the recorded data from the recording medium 504.

[0046]

As described above, by registering in advance, the  
25 function can be realized without the need to install a dedicated sound signal processing chip (DSP) or a CPU

capable of performing high-speed real-time data processing.

[0047]

The speakers that constitute the 3D surround system achieves 5.1 ch. by six speakers, i.e., the right front SP 511, the left front SP 512, the center SP 513, the right rear SP 514, the left rear SP 515, and the subwoofer 516. In other words, the 5-channel speakers 511 through 515 reproduce the sound in the bandwidth of 20 Hz to 20 kHz while the dedicated subwoofer 516 only reproduces the sound of the lower bandwidth of 120 Hz or less. Since the subwoofer 516 has a narrow reproduction bandwidth, it is considered as "0.1 ch." and the system as a whole is referred to as 5.1 ch. It realizes acoustic environment which is further stereoscopic and realistic compared to a stereo output and enables flexible movement of a sound field, and woofer creates an overwhelming space.

[0048]

However, the speakers constituting the 3D surround system is not limited to 5.1 ch., and may be a group of plurality of speakers controlled independently such as 6.1 ch.

[0049]

(Contents of Guidance Patterns)

Next, contents of typical guidance patterns of the navigation device according to the embodiment of the present invention are described. Figs. 6 through 10

illustrate examples of typical guidance patterns of the navigation device according to the example of the present invention. Note that the following guidance patterns are the typical patterns and a variety of patterns are present  
5 in practice.

[0050]

Guidance Pattern 1 (Right Direction Guidance):

As shown in Fig. 6, for example, at 300 meters before the branch point the guide tone "pong" is reproduced,  
10 followed by the reproduction of the guide voice "turn right soon". At this time, the virtual sound sources for both are set forward. That is, both the output of the guide tone and the output of the guide voice above are controlled so that both the guide tone and the guide voice  
15 are heard from the front side (1).

[0051]

Then, just before the branch point (intersection), the guide tone "pong" is reproduced while moving the virtual sound source in the traveling direction (right  
20 direction). That is, the output of the guide tone above is controlled so that the guide tone is heard as if moving rightward from the front side (2). Subsequently, the guide voice "turn right" is reproduced. At this time, the virtual sound source is set rightward to which the guide  
25 tone is moved. That is, the output of the guide voice is controlled so that the guide voice is heard from the right

side (3).

[0052]

Guidance Pattern 2 (Straight-Through Guidance):

As shown in Fig. 7, for example, at 300 meters before  
5 the branch point, the guide tone "pong" is reproduced,  
followed by the reproduction of the guide voice "proceed  
straight along". At this time, the virtual sound sources  
for both of them are set forward. That is, both the  
output of the guide tone and the output of the guide voice  
10 above are controlled so that both the guide tone and the  
guide voice are heard from the front side (1).

[0053]

Then, just before the branch point (intersection),  
the guide tone "pong" is reproduced while moving the  
15 virtual sound source in the traveling direction (front  
direction). That is, the output of the guide tone above  
is controlled so that the guide tone is heard as if moving  
frontward (2). Subsequently, the guide voice "proceed  
straight" is reproduced. At this time, the virtual sound  
20 source is set frontward to which the guide tone is moved.  
That is, the output of the guide voice is controlled so  
that the guide voice is heard from further ahead (3).

[0054]

Guidance Pattern 3 (Diagonally Right Direction  
25 Guidance):

As shown in Fig. 8, for example, at 300 meters before

the branch point, the guide tone "pong" is reproduced, followed by the reproduction of the guide voice "turn diagonally right soon". At this time, the virtual sound sources for both the guide tone and the guide voice are  
5 set forward. That is, both the output of the guide tone and the output of the guide voice above are controlled so that both the guide tone and the guide voice are heard from the front side (1).

[0055]

10 Then, just before the branch point (intersection), the guide tone "pong" is reproduced while moving the virtual sound source in the traveling direction (diagonally right direction). That is, the output of the guide tone above is controlled so that the guide tone is  
15 heard as if moving diagonally rightward from the front (2). Subsequently, the guide voice "turn diagonally right" is reproduced. At this time, the virtual sound source is set diagonally rightward to which the guide tone is moved. That is, the output of the guide voice is controlled so  
20 that the guide voice is heard from the diagonally right side (3).

[0056]

Guidance Pattern 4 (Diagonally Backward Left Direction Guidance):

25 As shown in Fig. 9, for example, at 300 meters before the branch point, the guide tone "pong" is reproduced,

followed by the reproduction of the guide voice "turn diagonally backward left soon". At this time, the virtual sound sources for both of them are set forward. That is, both the output of the guide tone and the output of the guide voice above are controlled so that both the guide tone and the guide voice are heard from the front side (1).  
[0057]

Then, just before the branch point (intersection), the guide tone "pong" is reproduced while moving the virtual sound source in the traveling direction (diagonally backward left direction). That is, the output of the guide tone above is controlled so that the guide tone is heard as if moving toward diagonally backward left direction from the front side(2). Subsequently, the guide voice "turn diagonally backward left" is reproduced. At this time, the virtual sound source is set to diagonally backward left to which the guide tone is moved. That is, the output of the guide voice is controlled so that the guide voice is heard from the diagonally backward left side (3).  
[0058]

#### Guidance Pattern 5 (Consecutive Guidance):

As show in Fig. 10, for example, at 300 meters before the branch point, the guide tone "pong" is reproduced, followed by the reproduction of the guide voice "turn right soon and then left". At this time, the virtual

sound sources for both are set forward. That is, both the output of the guide tone and the output of the guide voice above are controlled so that both the guide tone and the guide voice are heard from the front side (1).

5 [0059]

Then, just before the branch point (intersection), the guide tone "pong" is reproduced while moving the virtual sound source in the traveling direction (right→left) in the shape of a crank. That is, the  
10 output of the guide tone above is controlled so that the guide tone is heard as if moving rightward from the front side and then diagonally rightward, i.e., the direction parallel to the traveling direction (2). Subsequently the guide voice "turn right and then left" is reproduced. At  
15 this time, the virtual sound source is set diagonally rightward to which the guide tone is moved. That is, the output of the guide voice is controlled so that the guide voice is heard from the diagonally right side (3).

[0060]

20 As described above, the virtual sound source is set in accordance with the relative position of the self-vehicle to the position of the guidance point of the route guidance so that the guidance is heard from the direction of the guidance point. The reproduction of the guidance  
25 by setting the virtual sound source at the guidance point may be performed only for the guidance just before the

guidance point, while preliminary guidance is reproduced by setting the virtual sound source toward the front regardless of the guidance contents. In this manner, the guidance can always be heard from the traveling direction.

5 [0061]

In addition, by reproducing only the guide tone as if the virtual sound source thereof is moving in the turning direction from the front side and reproducing the guide voice as if the virtual sound source thereof is present at the point to which the vehicle is turning, the guidance can be reproduced more directionally, while avoiding the contents of the guidance to be less audible.

[0062]

(Procedure of Process by Navigation Device)

15 Next, the procedure of the navigation device according to the example of the present invention will be described. Figs. 11 and 12 are flowcharts illustrating the procedure of the navigation device according to the example of the present invention.

20 [0063]

As shown in the flowchart in Fig. 11, the position information on the current position of the self-vehicle is captured first (step S1101). Then, the distance to the next guidance point is computed (step S1102).

25 Subsequently the speed information of the self-vehicle is captured (step S1103), and remaining time  $t$  to the above-



mentioned guidance point is computed based on the distance computed at step S1102 and the speed information captured at step S1103 (step S1104).

[0064]

5       Next, it is determined whether the remaining time  $t$  computed at step S1104 is equal to or shorter than the time left until timing preliminary guided, i.e.,  $t \leq$  the timing of the preliminary guidance (step S1105). When  $t >$  the timing of the preliminary guidance (step S1105: NO),  
10   the procedure proceeds to step S1109 without doing anything.

[0065]

      In contrast, when  $t \leq$  the timing of the preliminary guidance at step S1105 (step S1105: YES), then it is  
15   determined whether the computed remaining time  $t$  is equal to or shorter than the time left until timing of immediately-prior guidance, i.e.,  $t \leq$  the timing of the immediately-prior guidance (step S1106).

[0066]

20       At step S1106, when  $t \leq$  the timing of the immediately-prior guidance (step S1106: YES), the procedure proceeds to step S1201 of the flowchart shown in Fig. 12. In contrast, when  $t >$  the timing of the immediately-prior guidance (step S1106: NO), the virtual sound source  
25   reproduces the guide tone set in front (step S1107), followed by the virtual sound source reproducing the guide

voice set forward (step S1108), and then the procedure proceeds to step S1109.

[0067]

Subsequently, it is determined whether it has arrived  
5 at the destination at step S1109. If it has not arrived  
at the destination yet (step S1109: NO), the procedure  
returns to step S1101 to repeat the processing of the  
respective steps at steps S1101 through S1109, and if it  
has arrived at the destination at step S1109 (step S1109:  
10 YES), a series of the process is ended.

[0068]

As shown in the flowchart in Fig. 12, the guidance  
pattern is judged first (step S1201). When the guidance  
pattern is the right direction guidance pattern, the  
15 procedure proceeds to step S1211 and the virtual sound  
source reproduces the tone set to move rightward (step  
S1211). Subsequently, the virtual sound source reproduces  
the voice set rightward (step S1212). Then, the procedure  
proceeds to step S1109 illustrated in Fig. 11.

20 [0069]

When the guidance pattern is the straight-through  
guidance pattern, the procedure proceeds to step S1221 and  
the virtual sound source reproduces the tone set to move  
frontward (step S1221). Subsequently, the virtual sound  
25 source reproduces the voice set frontward (step S1222),  
and then the procedure proceeds to step S1109 illustrated

in Fig. 11.

[0070]

When the guidance pattern is the diagonally right direction guidance pattern, the procedure proceeds to step  
5 S1231 and the virtual sound source reproduces the tone set to move diagonally rightward (step S1231). Subsequently, the virtual sound source reproduces the voice set diagonally rightward (step S1232), and then the procedure proceeds to step S1109 illustrated in Fig. 11.

10 [0071]

When the guidance pattern is the diagonally backward left guidance pattern, the procedure proceeds to step  
S1241 and the virtual sound source reproduces the tone set to move diagonally backward left (step S1241).

15 Subsequently, the virtual sound source reproduces the voice set diagonally backward left (step S1242), and then the procedure proceeds to step S1109 illustrated in Fig.  
11.

[0072]

20 When the guidance pattern is the consecutive guidance pattern, the procedure proceeds to step S1251 and the virtual sound source reproduces the tone set to move consecutively (right→left) (step S1251). Subsequently, the virtual sound source reproduces the voice set  
25 diagonally rightward (step S1252), and then the procedure proceeds to step S1109 illustrated in Fig. 11.

[0073]

Note that the guidance patterns in the flowchart are the typical patterns and a variety of patterns are present in practice.

5 [0074]

(Contents of Safety Guidance)

Next, contents of safety guidance are described.

When there is a railroad crossing or a lane ends ahead in the traveling direction and the guide sound is to be reproduced in advance for warning, the guide tone with the low-pitched sound being emphasized is reproduced upon reproducing the guide sound to call attention more. In this case, the subwoofer 516 is used for emphasis of the low-pitched sound. Figs. 13 and 14 illustrate other examples of the typical guidance pattern of the navigation device according to the example of the present invention, representing the contents of the safety guidance.

[0075]

As shown in Fig. 13, before the railroad crossing, the guide tone "pong" is reproduced by the virtual sound source set forward while emphasizing the low-pitched sound (1). Subsequently, the guide voice "watch a railroad crossing ahead" is reproduced. At this time, the virtual sound source is set forward (2).

25 [0076]

As shown in Fig. 14, before a lane ends, the guide

tone "pong" is reproduced by the virtual sound source set forward while emphasizing the low-pitched sound (1).

Subsequently, the guide voice "watch, only one lane ahead" is reproduced. At this time, the virtual sound source is

5 set forward (2). Although illustration is omitted here, the virtual sound source may also be set so that the guide tone moves in the direction of the lane to which the vehicle should be moved.

[0077]

10 (Destination Location Guidance)

Next, contents of destination guidance are described.

By operation of the operator, voice guidance of the destination is reproduced as if the voice guidance is heard from the direction of the destination. Fig. 15

15 illustrates another example of the typical guidance pattern of the navigation device according to the example of the present invention, representing the contents of the destination guidance.

[0078]

20 As shown in Fig. 15, when the destination is in the diagonally right direction from the self-vehicle position, the virtual sound source is set at the destination to reproduce the guide tone "pong" and then the guide voice "13 kilometers to the destination. It takes about 17  
25 minutes".

[0079]

Incidentally, while the above examples are described with respect to a car navigation device, similar contents may be realized in mobile navigation for a portable telephone or the like using headphones equipped with the  
5 3D surround system, for example.

[0080]

As described above, according to the embodiment, the 3D surround system 100 including plural speakers is provided, the guidance-information acquiring unit 101  
10 acquires the information on the route guidance, and the control unit 102 controls the output of the guide sound so that the direction from which this guide sound is heard moves based on the information acquired by the guidance-information acquiring unit 101 using at least two speakers  
15 included in the speaker group 103 at the same time, so that it can be recognized intuitively that the direction to which the guide sound is moved is the guidance direction, enabling misconception of the guidance direction being reduced.

20 [0081]

Moreover, according to the embodiment, the control unit 102 controls the output of the guide sound to be heard substantially from the front side of the traveling direction and then to be moved substantially toward the  
25 guidance direction based on the information acquired by the guidance-information acquiring unit 101. As a result,

the driver can recognize the guidance direction with less feeling of uncomfortableness.

[0082]

Moreover, according to the embodiment, the control  
5 unit 102 controls the output of the sound effect included  
in the guide sound (for example, the tone) to be heard  
substantially from ahead in the traveling direction, then  
to be moved substantially toward the guidance direction,  
and subsequently controls the output of the guide voice  
10 included in the guide sound to be heard substantially from  
the guidance direction, thereby avoiding the voice to be  
less audible because only the tone is moved while the  
voice is not moved.

[0083]

15 Furthermore, according to the embodiment, the control  
unit 102 carries out the control only for the guidance at  
a point just before the branch point. Thus, it is  
possible to intuitively recognize the guidance of which  
the guide sound moves is the immediately-prior guidance.

20 [0084]

Moreover, according to the embodiment, the 3D  
surround system 100 including plural speakers is provided,  
the guidance-information acquiring unit 101 acquires the  
information on the guidance, and the control unit 102  
25 controls the output of the guide sound based on the  
information (for example, the hazard information or the

attention-calling information in the traveling direction)  
acquired by the guidance-information acquiring unit 101  
using the low-pitched sound speaker 104 included in the  
speaker group 103 and the speaker group 103 at the same  
5 time, so that, using the subwoofer 104 upon outputting the  
guidance information when the guidance information is the  
hazard information or the attention-calling information,  
it can be perceived unconsciously that there is a  
dangerous situation or the situation that the attention  
10 must be called in the traveling direction, thereby  
allowing to contribute to safer driving and travel.  
[0085]

Furthermore, according to the embodiment, the 3D  
surround system 100 is provided, the predetermined-point-  
15 information acquiring unit 105 acquires the information on  
the predetermined point, such as the information on the  
destination point in the route guidance or the registered  
point which is set arbitrarily, and the control unit 102  
controls the output of the guide sound to be heard from  
20 the direction of the predetermined point based on the  
information acquired by the above-mentioned predetermined-  
point-information acquiring unit 105, so that, by  
notifying the direction of the predetermined point (for  
example, the destination point or the registered point)  
25 with the guide sound, it can be recognized readily of the  
direction of the predetermined point, such as the



destination point or the registered point toward which the vehicle is traveling at present, without checking the display screen.

[0086]

5       The navigation method according to the embodiments may be a program prepared in advance that can be read by a computer (for example, a microcomputer), and is achieved by executing the program by the computer. The program is recorded on the computer-readable recording medium, such  
10 as the HD, an FD, a CD-ROM, an MO, and the DVD, and is executed by the computer reading out from the recording medium. In addition, the program may be a transmission medium that can be distributed through a network such as the Internet.